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# Table of Contents

## E46 IHKR

<b>Subject</b>	<b>Page</b>
Purpose of the System. . . . .	3
System Components. . . . .	4
IHKR Control Unit. . . . .	6
IHKR Housing. . . . .	6
Principle of operation. . . . .	7
Blower adjustment. . . . .	7
Air Distribution. . . . .	7
Temperature Control. . . . .	8
Engine Map Cooling. . . . .	9
Service Station Feature. . . . .	9
Air Conditioning Control. . . . .	10
Air Intake. . . . .	11
Ram Effect Air Compensation. . . . .	11
Rear Window Defroster. . . . .	12
Workshop Hints. . . . .	13
Review Questions. . . . .	15

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## **E46 IHKR**

**Model: E46 (325i/it/Ci/Cic, M3)**

**Production Date: From 9/00**

### **Objectives**

After completing this module you should be able to:

- Recognize the climate control functions performed by the IHKR system.
- Identify the changes compared to the E46 IHKA system.
- Understand the method of temperature control used by the IHKR.
- Describe how the A/C compressor is controlled.

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## Purpose of the system

The 325i/it/Ci/Cic and M3 will be fitted with IHKR as standard equipment. The IHKA system will be available as an option on these models.

IHKR is a semi-automatically regulated heating and air-conditioning system, similar to the IHKR introduced for the 2001 E39.

The purpose of the system is to allow the vehicle occupants to select the desired temperature, air outlet distribution and volume manually.

The system then automatically regulates the temperature of the cabin based on the manual settings.



The functions provided by the E46 IHKR are:

- Control of the blower.
- Air distribution control.
- Stratification flap controlled by a bowden cable
- Temperature Control
- Service Station feature
- Air conditioning request to DME
- Recirculation air
- Ram effect air compensation
- Rear window defroster

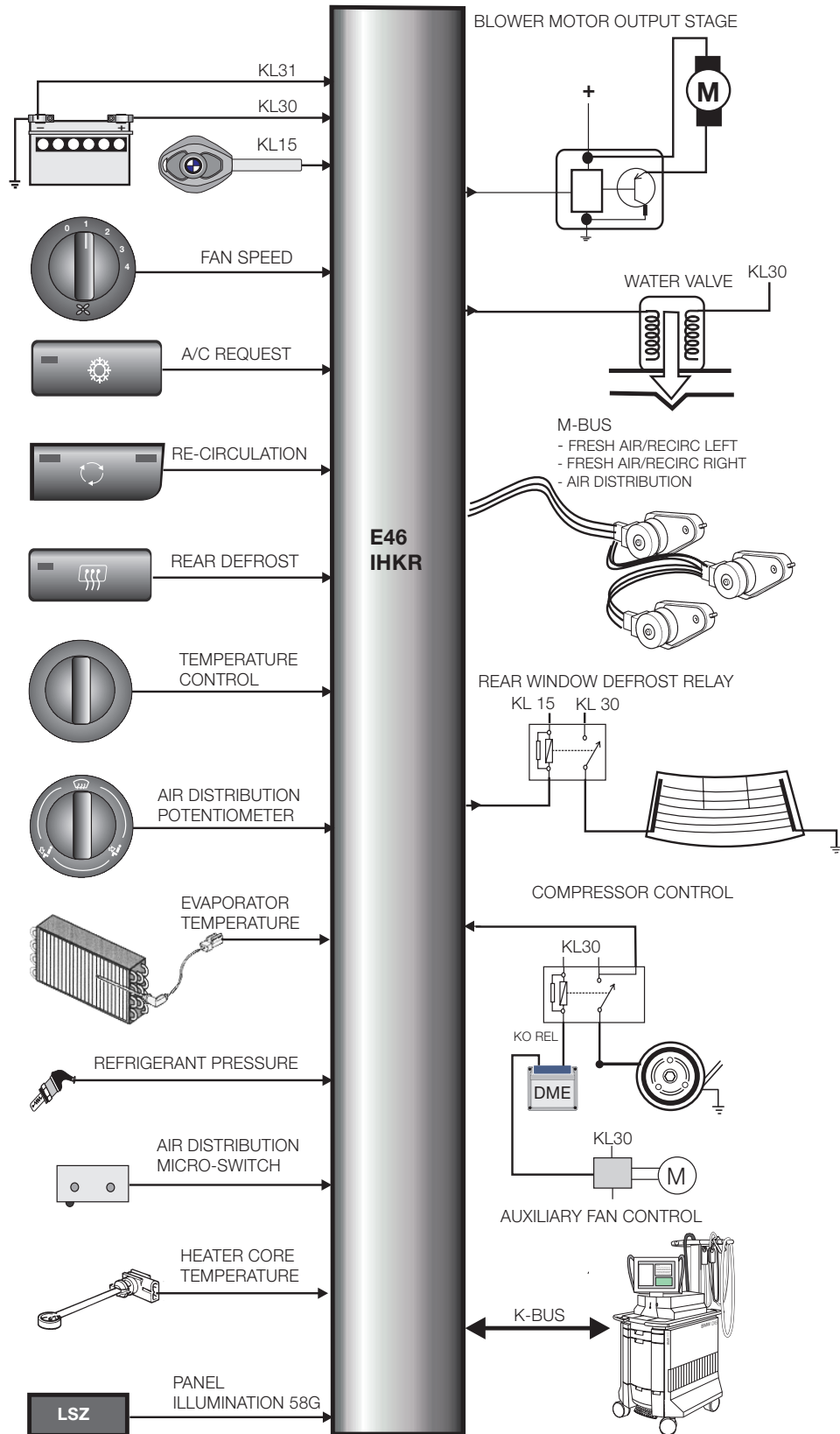
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## System Components

The E46 IHKR consists of the following components:

- IHKR control unit with operating controls
- IHKR integrated heater and air conditioning case
- Heater core temperature sensor
- Evaporator temperature sensor
- Refrigerant circuit pressure sensor
- Double cage blower motor and final stage
- Water valve
- Air distribution micro-switch
- M-bus with 3 smart stepper motors:
  - Air distribution
  - Fresh air/re-circulation left (high speed motor)
  - Fresh air/re-circulation right (high speed motor)
- Compressor relay (DME controlled)
- Auxiliary fan (DME controlled)
- Rear window defroster relay
- K-bus interface
  - The following signals are transmitted and received over the K-bus:
    - Vehicle speed
    - Engine speed
    - Coolant temperature
    - Outside temperature
    - Terminal 15, 61, 50,58G (panel lighting)
    - Compressor load
    - Diagnosis and coding
    - Compressor request
- Fresh air Micro-filter

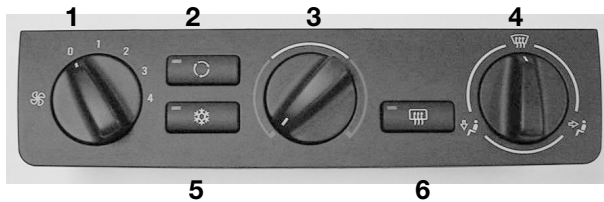
# E46 IHKR I.P.O



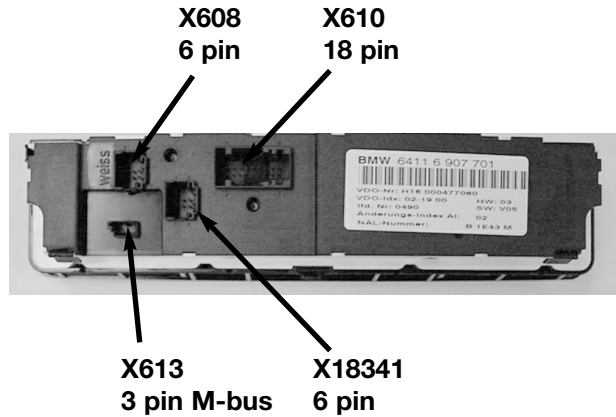
## IHKR control unit with operating controls

The IHKR control unit is incorporated into the control panel. The control panel consists of three buttons and three rotary dials. The control unit communicates over the K bus.

1. Blower control potentiometer
2. Recirculation button
3. Temperature control potentiometer
4. Air distribution potentiometer

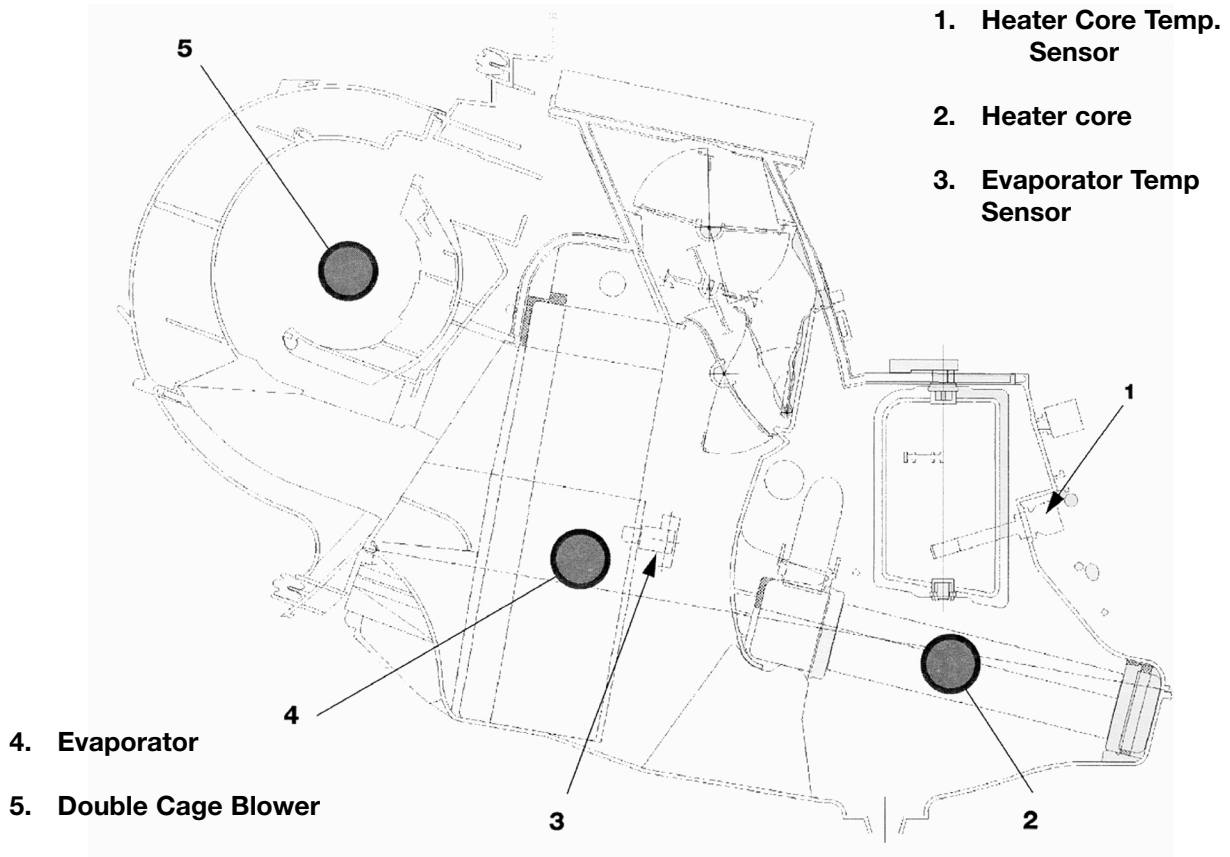


5. Air conditioning request button
6. Rear window defroster button



## IHKR Case

The E46 IHKR case is similar in design to the E46 IHKA heating and A/C case.



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## Principle of operation

### Blower adjustment

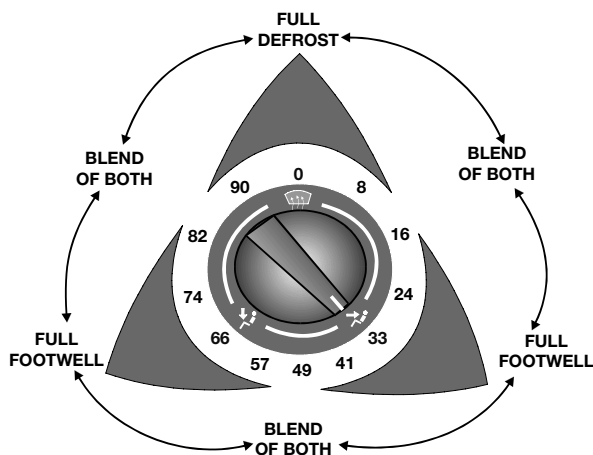
The blower rotary dial potentiometer has four settings. Each progressive step represents a 25% increase in blower volume. The control unit determines the desired blower setting by the signal from the potentiometer and then sends a voltage signal to the final stage unit. The voltage signal to the final stage unit ranges from 1.8V to a maximum of 7.1V (Normal blower power in Key Memory).

The final stage unit then regulates blower motor voltage to control the blower volume. There is no automatic influence on the blower setting.

The blower control potentiometer is the master on/off switch for the IHKR system. The water valve is closed (energized) in the blower zero (off) position. The LEDs for re-circulated air and air conditioning are switched off and the compressor is switched off. The rear defroster operation is not affected by the system being switched off.

### Air distribution

The selection of air distribution is carried out using the rotary dial potentiometer (42 steps). Each step of the potentiometer represents a percentage. The percentage indicates the desired air distribution setting.



Movement of the stratification flap for face ventilation is carried out by rotating a thumb wheel between the face vent discharge nozzles. The thumb wheel is connected to a bowden cable that moves the flap.

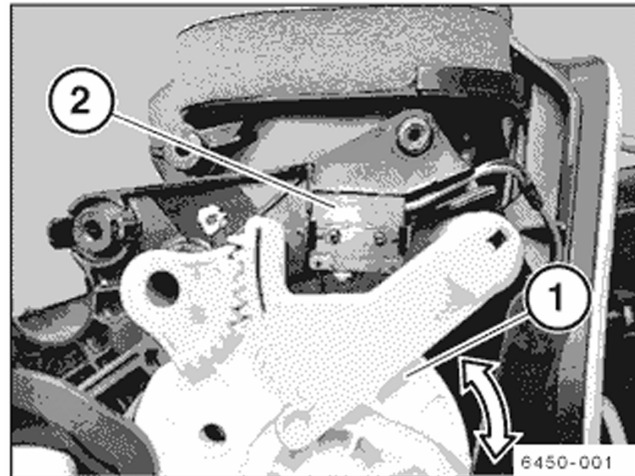
The air distribution for defrost, ventilation and footwell is performed by a single air distribution stepper motor that is connected to the M-bus and controlled by the IHKR control unit.

The stepper motor drives a cam/lever assembly (1) that articulates all three air distribution flaps. The position of the cam is confirmed by the air distribution micro-switch (2).

The air distribution micro-switch is provided 5V by the IHKR control unit. The micro switch is closed by the rotating cam lobe in two positions:

- Full defrost 97% to 0%
- Mixed face vent/footwell 37%  
(quick confirmation)

When the switch is closed the signal at the control unit goes low, informing the control unit that it has reached that particular position. The display in diagnosis recognizes this position as “off”.



**Located on the right side of the IHKR case**

A reference run is initiated the first time KL30 is switched on the IHKR control unit. The reference run is required to determine the position of the cam disc. The cam disc is rotated until the micro-switch sends a signal to the control unit. After the reference run is completed, the control unit recognizes what position the cam disc is in and thus the position of all three air distribution flaps.

If the air distribution micro-switch is not able to produce a signal at the correct position, the control unit will continue to operate the stepper motor at an estimated position. Eventually the air distribution setting will not match the actual output. The air distribution micro-switch circuit is fault monitored.

## **Temperature control**

The desired interior temperature is set with the rotary dial potentiometer (34 steps). The face of the dial itself has no marked temperatures, just a blue, white and red line that represents a comfort zone.

All of the air flowing into the IHKR housing must pass through the evaporator first before being re-heated by the heater core. This is the principle used by all IHKR and IHKA systems.

The IHKR maintains the temperature of the discharge air by cycling the water valve to regulate the temperature of the heater core. The duty cycle applied to the water valve is based on the “Y-factor” (correcting variable) and other variables.



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The Y-factor of the E46 IHKR is determined by:

- Setting of the temperature control dial
- Outside temperature (from Kombi via the K-bus)
- Heater core temperature

Automatic temperature control is switched off when the temperature control dial is turned all the way to the left (blue: water valve closed) or right (red: water valve full open) stop.

Each step of the potentiometer represents a temperature from max. cold (10°C) to max. warm (49.5°C). This temperature value is combined with the outside temperature to form a calculated set-point. The E46 IHKR does not use an interior temperature sensor.

The Y-factor is then determined by comparing the calculated set-point to the actual value of the heater core sensor which is in the stream of air to the outlet ducts.

In addition to the Y-factor, the control unit evaluates coolant temperature and engine RPM to determine water valve opening time. The valve opening times are:

- 0 ms at max. COLD
- 3600 ms at max. WARM

### **Engine map cooling**

Map cooling is used by the DME MS 43.0 for the M54 engines. This can create very high coolant temperatures which could be damaging to the climate control system. If the heater core temperature exceeds 80°C, the water valve is closed until the temperature drops below 80°C.

If the temperature at the heater core increases above 93°C (i.e. water valve faulty), the IHKR will signal the DME (via K-bus/Kombi/CAN) to energized the map cooling thermostat.

### **Service Station Feature**

The service station feature prevents the vehicle occupants from getting a blast of hot air after the vehicle is restarted following a short stop. The water valve is powered closed by the IHKR control unit for three minutes after shut-off. This prevents the heater core from being flooded with hot coolant.

## Air Conditioning control

The air conditioning system is switched on by pressing the snow flake button and having the blower dial on position 1 or greater. The LED in the button signals that the A/C is in stand-by.

The IHKR control module sends the following signals to the DME over the K-bus-Kombi-CAN -bus connection:

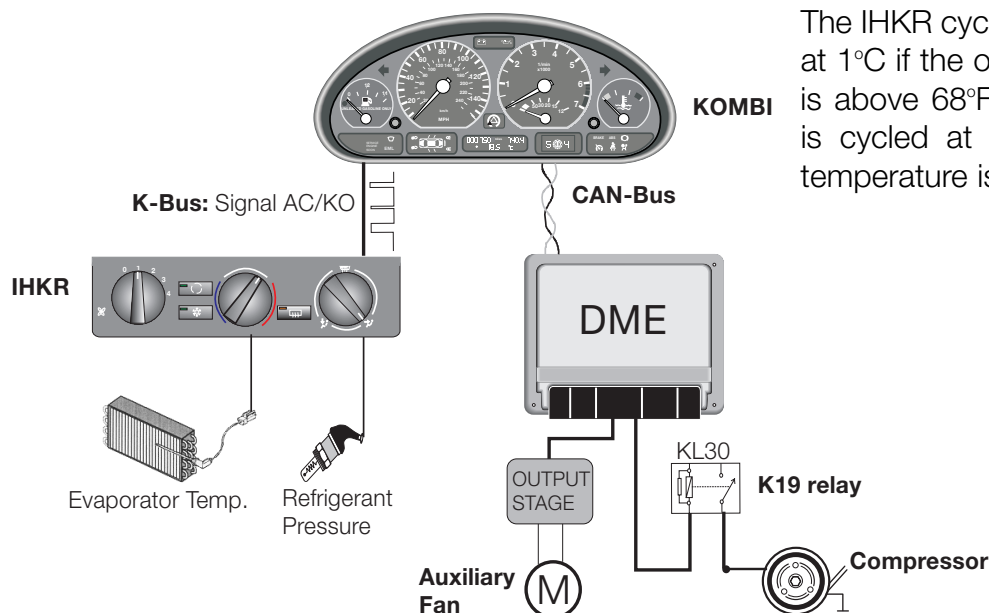
- IHKR on stand-by (signal AC)
- Request for A/C activation (signal KO)
- Calculated compressor load
- Request for auxiliary fan

The IHKR determines the load torque for compressor activation and required auxiliary fan speed from the pressure sensor mounted on the high side line next to the receiver dryer.

The refrigerant pressure sensor provides a voltage input signal (0-5 volts) to the IHKR. The voltage value increases as pressure in the high side refrigerant circuit increases. The IHKR processes this signal to determine the calculated load that will be placed on the engine when the compressor is switched on. Pressure values that are too high or too low will cause the compressor to be switched off.

Once all of the criteria for compressor operation have been met, the DME control module will activate the compressor relay to energize the compressor magnetic clutch.

Control of the evaporator temperature is carried out by the IHKR signalling the DME to shut off the compressor when the evaporator reaches the freezing point.



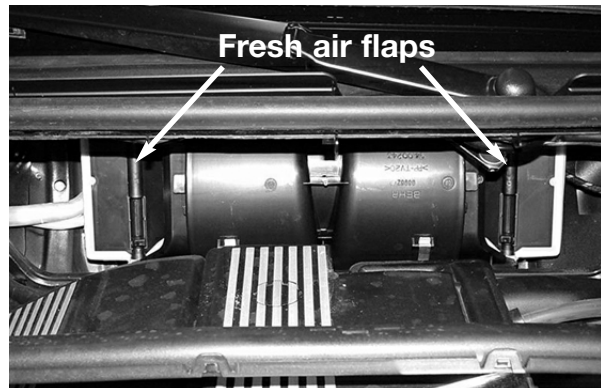
The IHKR cycles the compressor at 1°C if the outside temperature is above 68°F. The compressor is cycled at 3°C if the outside temperature is below 68°F.

## Air Intake

The fresh air/re-circulation flaps are controlled by a separate stepper motor for the left and right side.

The stepper motors are controlled by the M-bus and are located on the left and right sides of the housing inside the passenger compartment.

The fresh air flaps are closed and the re-circ doors are opened when the re-circ. button is pressed with the system switched on.



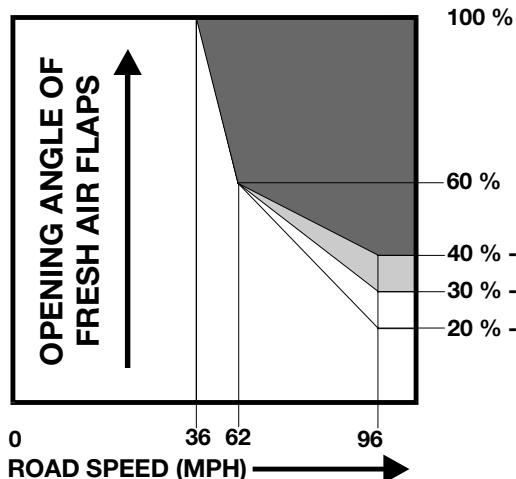
When the key is turned off with re-circulation on, the fresh air flaps will open. Re-circulation memory in the IHKR control unit is 15 minutes. If the vehicle is started within 15 minutes the re-circulation setting will be restored.

If the system is shut off with the blower switch, the re-circulation function will have to be re-enabled.

## Ram effect air compensation

Similar to IHKA, when the fresh air flaps are open their position is affected by vehicle road speed. This is to prevent an increase in air volume to the cabin with increasing vehicle speed.

The IHKR receives the vehicle speed input every 2 seconds over the K-bus from the Kombi. At a speed of 36mph the fresh air flaps will close progressively until the vehicle reaches 96mph, at which time the opening of the flaps will be 20%.

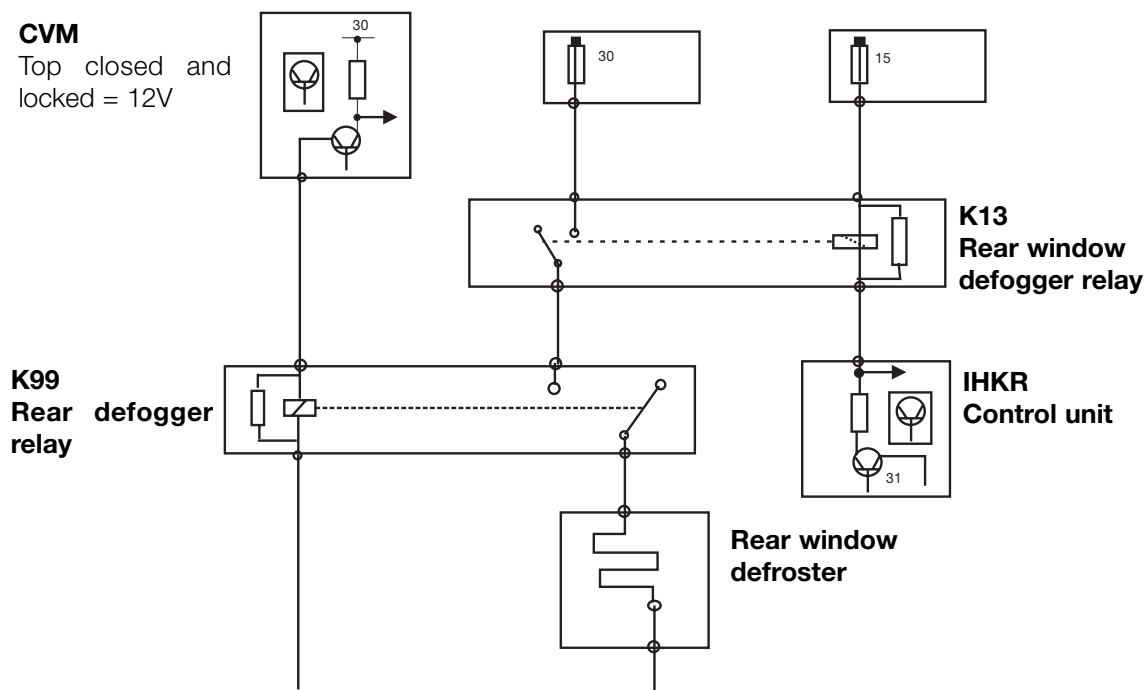


## Rear window defroster operation (All models)

The rear window defroster is controlled via a request from the button on the panel. After switching on for the first time, the rear window is heated for 17 minutes. Output voltage to the window is provided by the K13 rear defogger relay.

After automatic switch off, if the button is pressed once again the control unit will provide another 17 minutes of operation. If the vehicle voltage drops below 11.4V during this second heating operation the function is stopped, however the LED on the button will not be extinguished. If voltage increases past 12.2V for at least one second, operation will resume. The control circuit of the convertible varies slightly due to the folding top.

### Defroster operation specific to Convertibles



When the button is pressed on the IHKR control panel, relay K13 is energized. K13 supplies KL 30 to defroster relay K99. Relay K99 is energized when the KLR is switched on and the soft top is closed and locked to the windshield frame. This completes the circuit and allows the rear window to be heated.

If the soft top is lowered during defroster operation, voltage to relay K99 is interrupted by the CVM to prevent the rear window grid from heating when the top is lowered into the storage compartment.

## Workshop Hints

### Diagnosis

Diagnosis of the E46 IHKR system is carried out using the DISplus or MoDiC. The IHKR is connected to the diagnostic bus via the K-bus/Kombi connection. The system uses the E46 test module driven diagnostic concept for troubleshooting faults with the system.

#### Control Unit Functions:

Expert mode diagnosis available at any time during troubleshooting. To enter: press the Control Unit Functions button at the lower right corner of the screen.

The contents are:

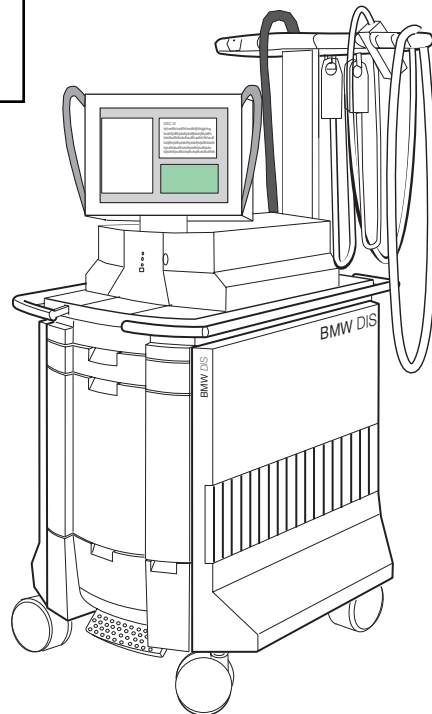
- **Identification**
- **Clear Fault Memory**
- **Read Fault Memory**
- **Component Activation**
- **Status Requests**

#### Service Functions:

Provides access to specialized test modules used as post repair procedures. To enter:

- Function selection
- Service Functions
- Body
- Heater- A/C control

#### Deactivate transport-lock function



**Test Modules:** Faults with the E46 IHKR can be diagnosed using fault or symptom driven test modules. To begin diagnosis:

- Perform the Short Test
- Select a vehicle symptom from the Symptom Selection page
- Select a test module from the Test Plan page
- Press the Test Schedule button

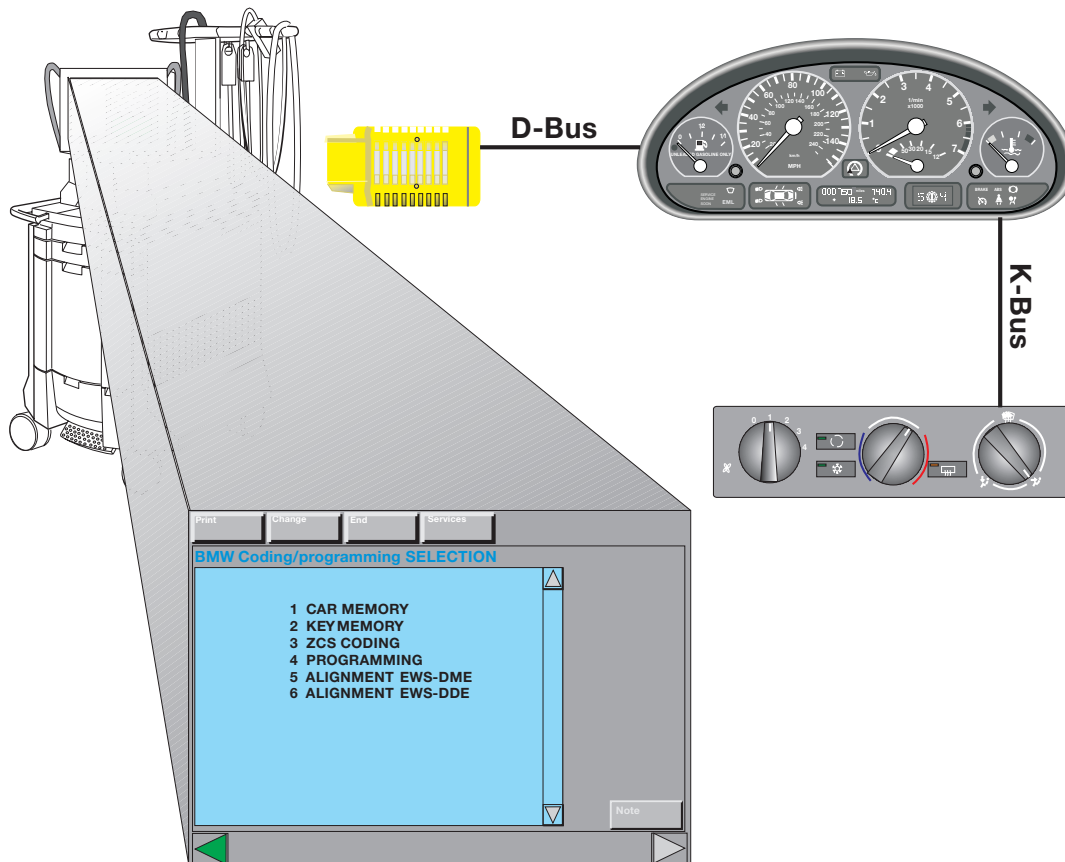
Test module are written in the E46 diagnosis style.

## Coding

Coding must be performed if the IHKR control unit is replaced. ZCS coding is found in the Coding and Programming selection from the start screen or when pressing the Change button. Follow on-screen instructions to remove KL 30 power to the IHKR control unit. This step is necessary to complete the coding process.

## Car and Key Memory

When troubleshooting complaints with the E46 IHKR it is important to note that because the Car/Key Memory feature can change the operation of the system, a review of the settings should be made prior to beginning troubleshooting.



Only Key Memory selections are possible for the E46 IHKR. The selections are:

- Set Blower Power (Raise, Normal, Lower)
- Correction Set Temperature (raise/lower)
- A/C on at key on (Automatic activation of the compressor control when the ignition is switched on.)

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## Review Questions

1. What is the Voltage range of the control signal from the IHKR to the blower final stage?

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2. Which components are responsible for the movement of the air distribution flaps? What role does the air distribution micro-switch play? \_\_\_\_\_

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3. How does the IHKR determine a Y-factor if the system does not use an interior temperature sensor? \_\_\_\_\_

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4. How does the IHKR signal the DME when compressor activation is requested? Discuss what information is exchanged. \_\_\_\_\_

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5. What three stepper motors are located on the M-Bus? What is an M-Bus?

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6. Which additional component is used in the rear defrost circuit of a convertible E46, as compared to a hard top? \_\_\_\_\_

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